OPERATIONAL REQUIREMENTS DOCUMENT

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NATIONAL AIR AND SPACE WARFARE MODEL (NASM)
Version 1.1
ACAT LEVEL III

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Table of Contents

		Page
1.	General Description of Operational Capability	3
2.	Threat	4
3.	Shortcomings of Existing Systems	4
	a. Model Representations	4
	b. Simulation System Support	5
4.	Capabilities Required	6
	a. System Performance	6
	b. Logistics and Readiness	20
	c. Critical System Characteristics	20
5.	Program Support	22
	a. Maintenance Planning	22
	b. Support Equipment	23
	c. Human Systems Integration	23
	d. Computer Resources	24
	e. Other Logistics Considerations	24
	f. Command, Control, Communications, Computers and Intelligence	25
	g. Transportation and Basing	26
	h. Standardization, Interoperability, and Commonality	26
	i. Mapping, Charting, and Geodesy Support	26
	j. Environmental Support	27
6.	Force Structure	27
7.	Schedule Considerations	27
Attachment 1:	Requirements Correlation Matrix	28
Attachment 2:	Glossary	41
Attachment 3:	Acronyms	43

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National Air and Space Warfare Model (NASM)
Operational Requirements Document (ORD)

1. General Description of Operational Capability

This Operational Requirement supports the mission need identified in Air Force Mission Need Statement (MNS) USAF 009-93. This MNS identified deficiencies associated with the Air Warfare Simulation (AWSIM) currently used for battlestaff training, and determined that a National Air and Space Warfare Model (NASM), developed as a partner program in the Joint Simulation System (JSIMS), is required to correct these deficiencies.

JSIMS is a single system, comprising a core infrastructure managed by the JSIMS Program Office, and mission-space representations developed by Joint agencies and the Services for their respective, specific domains. The Air Force Electronic Systems Center (ESC) is the Development Agent (DA) for JSIMS' air and space warfare domain, and the NASM program satisfies this requirement. NASM is not a stand-alone training system, but one of eight concurrent development programs in the JSIMS Enterprise. Requirements stated in this document encompass all Air Force requirements expected to be met by the JSIMS Enterprise, including those appropriate to the NASM development program.

JSIMS can be composed to support specific warfighting domains, service-unique training, and joint, combined and Air Force battlestaff training for audiences at all echelons from the Joint Task Force (JTF) commander down to wing level. It will also support the formulation, assessment, and evaluation of operational plans, and the development and evaluation of doctrine and tactics.

NASM will provide an operationally realistic, simulated mission space with physical and behavioral representations for aerospace roles and missions across the range of military operations, supporting multiple levels of resolution while ensuring consistent results across these levels. The NASM domain will include all air and space power functions in Air Force Doctrine Document (AFDD) 1. NASM will represent underlying environmental factors and processes such as terrain and weather, and infrastructure capabilities such as command and control (C2) and navigation. NASM will be flexible and extensible enough to address future operational needs and missions, and to incorporate additional aerospace functions for support of other Services' needs within JSIMS.

NASM will be a distributed simulation system with the capability to interact with geographically separated training audiences, and live, virtual, and other constructive simulations. NASM will interoperate with operational Command, Control, Communications, Computers, and Intelligence (C4I) systems to provide realistic training. NASM will include capabilities for distributed, collaborative planning (pre-exercise and exercise); scenario development (pre-exercise); simulation execution (exercise); and analysis of results (exercise and post-exercise).

NASM will use portable, reusable, and modular software components. Where practical NASM will use off-the-shelf hardware, software, validated algorithms, and existing databases to provide a more maintainable system with a longer life cycle.

2. Threat

Today's information technologies can create potential vulnerabilities for all C4I systems. The USAF must consider adversary techniques that corrupt, deny, exploit or destroy information through a variety of means. Although NASM is primarily a training system, its connectivity to operational systems such as the Theater Battle Management Core System (TBMCS) and other theater and national C4I systems makes it a potential target for information attack.

Threats to NASM include physical threats (i.e. sabotage, espionage, etc.), information collection threats (internal and external), data-denial or -manipulation threats (introduction of malicious codes or viruses), and reactive threats (identification of system capabilities or dependence could increase the possibilities of countermeasures). Connectivity to telecommunications networks in multiple, distributed locations and the incorporation of commercial technologies also have inherent threat implications to this system. Additional information concerning the threat can be found in DST-2660F-210-94 "Command, Control, Communications, Computers and Intelligence (C4I) Systems and Networks, Telecommunications Networks, and Automated Information Systems (AIS) Threat Environment Description (TED)" (U) 15 Jan 94, and in the Draft Information Warfare to Automated Information System TED.

3. Shortcomings of Existing Systems

AWSIM emerged from the Warrior Preparation Center (WPC) in the early 1980's as an adaptation and expansion of a model originally developed for the Navy in the early 1970's. The current version of AWSIM is the result of a re-engineering effort undertaken in 1994. AWSIM has a number of functional, maintenance, and fidelity limitations, identified in MNS USAF 009-93. The limitations are in two categories: model representations and simulation system support.

a. Model Representations

(1) AWSIM does not allow for more than two sides to play in a scenario, and does not allow neutrals to become combatants, nor allies to switch sides in scenarios.

(2) AWSIM does not adequately model logistics, to include air/ground mobility and resupply, maintenance, personnel, and non-weapon consumption rates.

(3) AWSIM does not adequately model visual, radar, or infrared detections, to include terrain, atmospheric and electromagnetic environmental effects, and low-observability concepts.

(4) AWSIM does not adequately model air-to-air engagements, including visual-range combat, modern weapons and cockpit factors, low-altitude operations, and flight dynamics.

(5) AWSIM does not adequately model air-to-ground engagements, to include delivery platform capabilities, targeting and weaponeering, weapons effects, ground threat effects, terrain and weather factors, and damage assessment.

(6) AWSIM does not adequately model surface-to-air engagements, to include salvo rate, launcher capacity, reload time, site configuration and mobility factors, missile time of flight, guidance modes, terrain, electronic combat effects, or C2 factors.

(7) AWSIM does not model space-based systems, to include launch vehicles, on-orbit support, platforms, sensors, and communications.

(8) AWSIM does not model fratricide and does not adequately address track-identification problems.

(9) AWSIM has no capability to represent Information Warfare (IW). AWSIM does not adequately include friendly or enemy C4I, which is the digital battlefield for IW.

(10) AWSIM depends on external models to show effects of electronic combat, intelligence collection and reporting, and space-based warning systems.

(11) AWSIM has no provisions for considering social, economic, or political factors across the full range of military operations.

(12) AWSIM does not model the strategic effects of air and space power, including the potential effects on enemy behavior, morale, and discipline.

b. Simulation System Support

(1) The scenario-generation capability does not validate scenarios, and does not allow an audit trail for tracking changes to the scenario.

(2) Exercise preparation is resource intensive and requires extensive manpower for supporting both Air Force-centric and joint training.

(3) AWSIM does not adequately interoperate with or represent operational C4I systems. Current work-arounds are limited and difficult to maintain.

(4) AWSIM lacks capabilities for error handling and error recording for determining the cause of problems. This deficiency occurs during both exercise execution and system maintenance.

4. Capabilities Required

The primary objective of NASM is to provide, in conjunction with JSIMS, a synthetic training environment in which battlestaffs (from the theater-commander level down to wing level) can practice decision making, and see the results of those decisions played out convincingly through simulation. The measures of NASM effectiveness relate to the quantity, quality, and credibility of those decision-making opportunities. NASM will provide JSIMS with air and space capabilities required to meet the JSIMS Key Performance Parameters (KPP) stated in the JSIMS ORD. Attachment 1 contains the Requirements Correlation Matrix, Parts I, II, and III.

a. System Performance

NASM must provide: (1) capabilities to host the simulation (model execution, interfaces to other models, player input/output, controller functions); (2) a simulated environment that represents the real world in which air and space missions occur (e.g., terrain, weather); (3) representations of physical entities (e.g., bases, aircraft, spacecraft, weapons, sensors, targets); (4) behavioral models that govern the interactions between entities (navigation, detection, communications, combat engagements, damage assessment, logistics); and (5) support modules (scenario and database preparation, aggregation of results and deaggregation of orders, translators for communicating results to operational C4I systems, familiarization training).

(1) The Simulation Process: NASM must provide the following capabilities:

(a) Core Structure (Common Framework): NASM representations must comply with the overall JSIMS core architecture to ensure interoperability with the other Joint and Service representations.

(b) Interfaces: NASM must comply with the Department of Defense (DoD) High Level Architecture (HLA), and interoperate with designated live, virtual, and constructive simulations outside of JSIMS.

(c) Data Deconfliction: NASM must provide consistent data to exercise participants at all sites in order to support distributed training over extended distances. NASM must ensure unambiguous interchange of data among system modules and between itself and external sources such as other Service models and virtual and live simulations. NASM must determine the outcome of each discrete event in a

manner that ensures consistent results are reported to the training audience at all levels of participation and at all locations. This may require centralized deconfliction in some configurations, especially where portions of the scenario are isolated and distributed to other models for resolution, and the outcomes must then be returned within the constraints of time-synchronized interfaces.

(d) Multiple Force Sides: NASM must support multiple player "sides" including multiple services from multiple nations in multiple coalitions, neutral forces (which may convert to active participants), suspect or unknown forces, and opposing forces. NASM must represent factions or international organizations that may not be directly associated with a recognized nation or government. The scenario database should determine the number of sides, unconstrained by software limits. Units and bases must be able to transfer sides during the exercise (e.g., if a base is overrun or forces are politically realigned).

(e) Transparency: NASM must allow trainees to train in their respective home stations or deployed C2 centers. NASM must not require trainees to use artificial means to input or receive data, nor can the system provide or require means of communication that would not ordinarily be available.

(f) Levels of Resolution and Aggregation: NASM must be able to generate data for each training audience consistent with the volume, format, level of detail, and quality received during real-world operations. NASM will be able to portray variable levels of fidelity, dictated by the scenario and training audience being supported. Resolution will increase as requirements for training lower-echelon units are incorporated. For example, if lower-echelon logistics play is an exercise objective, the model needs to represent logistics flows and constraints in detail, but if not an objective, the exercise controllers should be able to selectively turn off logistics constraints and detailed reports. For higher-level activities (where only senior staffs are involved), NASM must aggregate data as required to present results to the players in a realistic format, and deaggregate higher-level decisions into mission orders appropriate for entity-level execution in NASM. (See §4.a.(5), Support Modules.)

(g) Warfighter In The Loop (WITL) Capability: The primary Air Force training audience will be battlestaffs at and above the Air Operations Center (AOC) level. Below this level, tasks will be simulated in the model itself, or via support modules (to handle such tasks as mission planning to translate the Air Tasking Order (ATO) into individual flight orders). NASM, however, must allow WITL at lower levels within the simulation (such as mission-planning cells at the wing level or air-defense battle-management cells), and must be able to isolate entities in the model and link to detailed, external simulations (such as virtual simulator missions to resolve small-scale engagements). NASM must provide WITL SemiAutomated Forces (SAFOR) and fully automated Computer Generated Forces (CGF) to represent friendly, neutral, and opposing forces at all applicable levels. NASM will provide the ability to combine and switch between WITL and SAFOR or CGF.

(h) Simulation Time: NASM must run at rates ranging from slower than real time, to real time, to faster than real time. NASM will be able to jump time backward for replay or restart of a simulation. NASM will also be able to jump time further into a scenario. Time compression factors with respect to real time (i.e. run rates) should be selectable within a range from 1:1 to 4:1 for a Commander in Chief (CINC) or Commander Joint Task Force (CJTF) scenario. Game speeds greater than 1:1 are useful for analysis, mission rehearsal, or limited WITL exercise support with limited C4I connectivity. The objective range is from slower than real time at 1:10 to faster than real time at 100:1 (when using fully automated CGF).

NASM must be able to update simulation-unique displays independently of any simulation time-step. NASM must provide data at operational update-rates to operational systems participating in an exercise.

(i) Player Input/Output: NASM must provide a simple, organic interface when an operational C4I system is not the primary tool for a player interacting with the model. This interface must include, as a minimum, a visual display of the perceived air picture, access to status boards in table or database form, and the ability to insert mission orders. Combining these functions under a single, easy-to-learn graphic user interface (GUI) with intuitive menus and context-sensitive help is essential. Training times for these

NASM-specific interfaces should be no more than 2 hours for player familiarity, 6 hours for player proficiency, and 12 hours for controller proficiency. Additionally NASM must incorporate thorough error checking for syntax and context in player inputs, with the capability to challenge illogical commands and "catch" mistakes that would not happen in real-world situations (such as launching aircraft without weapons loads, or crashing while attempting to fly without fuel).

(j) Technical Control: NASM requires technical control functions to ensure the simulation operates within design parameters. Technical controllers must be able to start, freeze, stop, or restart the model, save all or selected portions of data, vary game speed, override event outcomes, and manage system configuration.

(k) Exercise Controller Privileges: The exercise controllers will operate in exercise control and response cells to serve as a buffer between exercise participants (trainees) and the simulation, to ensure that the exercise meets training objectives. At the exercise-director level, controllers will have access to unfiltered ground truth, and will have the ability to start or freeze the model, save data, vary game speed, and override event outcomes. Controllers must also have the ability to modify target lists, inventory levels, object characteristics, and order-of-battle databases while the model is running. NASM must provide varying levels of controller privileges, as appropriate for each location; at the response-cell level, for example, NASM may limit controllers to perceived truth. Controllers will supervise SAFOR control, role play as wing-level operations centers or air-defense cells, and interpret trainee responses and commands for input to the simulation. They will provide feedback to exercise participants via established, exercise communications links.

(l) Player Privileges: The NASM players (training audience and response cells) must be able to inject a new order or modify existing orders for their assigned forces commensurate with the training concepts, practices, and exercise objectives. The players must see and control only what the technical controllers have defined for each location. There will be a direct relationship between what the player can see and what the player can control. For example, players must not have knowledge of situations beyond their scenario-driven ability to collect or access data, and must not be able to give orders to forces under someone else's control.

(2) Mission Space Environment: The NASM battlespace includes the natural and man-made environment which influences interactions between modeled entities.

(a) Coordinate Systems: NASM must define objects' locations by accepted spherical coordinate system conventions (latitude, longitude, altitude). NASM must accept and automatically translate other common coordinate systems such as Universal Transverse Mercator (UTM) for purposes of order inputs and visual displays. NASM must be able to track objects in any location worldwide (including space), although exercise scenarios may focus on a single theater of operations.

(b) Terrain: NASM must use data from the National Imagery and Mapping Agency (NIMA) to represent natural and man-made terrain features (see §5.i, Mapping, Charting and Geodesy Support). NASM should tailor terrain resolution to the area and scope of the scenario in order to manage the volume of terrain data in a large-scale exercise. For example, in a European scenario it would be necessary to accurately represent terrain where outcomes of detections and combat engagements are critical, while it would be unnecessary for rear areas such as the continental United States (CONUS) where the only activity might be launch and recovery of airlift aircraft or spacecraft under benign conditions. As a minimum, NASM terrain attributes should include elevation, type (water, woods, desert, urban, mountainous, etc.), and man-made features such as political boundaries. NASM must accept substitute data where NIMA data are not available or not desired for a specific training scenario. NASM should be able to take advantage of greater fidelity and resolution in terrain as available databases improve. Modeled terrain should be available for display at variable levels of resolution, from simple overhead views of geopolitical outlines in adjustable scale (threshold requirement), to "birds eye" or cockpit view of terrain and model entities from selectable angle, elevation, and range (when technically feasible).

(c) Weather and Atmospheric Conditions: NASM must be able to represent weather and the effects of actual and forecast weather on all operations. NASM must be capable of representing weather conditions by linking to real-world data, replaying "snapshots" of historical data, or presenting credible, artificial weather-systems as an exercise driver. NASM must represent atmospheric conditions such as rain, snow, wind, smoke, dust, haze, fog, and clouds, along with their effects on electromagnetic-wave propagation at various frequencies. NASM must differentiate between actual ("reported") and forecast ("predicted") weather. A scenario's weather conditions during a mission must affect operations such as aircraft sortie generation, launch, recovery, reconnaissance and surveillance, aerial refueling, and target acquisition. NASM must include upper-atmospheric conditions and electromagnetic effects (such as solar flares, which affect communications). NASM must provide actual and forecast weather in formats normally available through operational communications, sensing, and forecast systems, including satellites which provide imagery.

(3) Model Entity Representations: NASM entities (such as airbases, aircraft, spacecraft, missiles, weapons, sensors, and communications nodes) must have specific characteristics that determine their behaviors and capabilities, and against which status can be reported throughout the exercise.

(a) Data Classes: NASM must represent all types of airbases, launch sites, aircraft, spacecraft, missiles, munitions, sensors, communication devices, and information, and differentiate subclasses which have significantly different behavior. For example, missiles might be split into surface-to-air, tactical air-to-surface, air launched cruise missiles, ground launched cruise missiles, theater ballistic missiles, and intercontinental ballistic missiles. Characteristics in each class should include detail sufficient to accurately represent significant behavior and differentiate capabilities and vulnerabilities. For example, aircraft characteristics might need to include parameters such as speeds (max, min, best cruise, preferred tactical low level); weapons, sensor, and cargo compatibility; fuel capacity and load options; fuel consumption as a function of speed, load, and altitude; radar cross section as a function of aspect angle; and maintenance and support requirements.

(b) Aggregation and Inheritance: NASM must represent higher-level objects (such as airbases) with characteristics of their own (such as location and operability status), characteristics and capabilities inherited from subordinate objects (such as runways, shelters, air defense sites, communications facilities, and maintenance facilities), and inventories of subordinate objects (aircraft, munitions, fuel, personnel). This object-oriented approach complies with JSIMS architecture conventions.

(c) Growth: NASM must represent air and space entities for other Services within JSIMS as directed and funded, and incorporate models of new and potential weapons systems (such as directed energy weapons) when defined.

(4) Behavioral Models: To provide a training audience with opportunities for theater-level decision making, NASM must credibly represent objects and processes which support all AFDD 1 functions plus air and space functions of the other Services. For each of these functions to be successfully represented in the synthetic mission space, NASM objects must interact with the natural environment and with each other. NASM must credibly represent targets and vulnerable processes, a means to attack or influence each target or process, and observable outcomes by which to judge the effectiveness of the action.

(a) Movement and Navigation: The movement of aircraft, spacecraft, and missiles must conform to accepted laws of motion and constraints in weather, terrain, routing, trafficability, availability of navigation aids, and system performance (including speed, altitude, payload, fuel, and configuration). NASM speed, range, and payload calculations for aircraft and missiles must fall within 10 percent (preferably within 5 percent) of values calculated via detailed planning using current operational, system-specific performance data for friendly systems, and best available data for threat systems (such as Defense Intelligence Agency estimates or approved OSD/PA&E modeling and simulation databases).

(b) Detection: Detection (including surveillance and reconnaissance) of objects in the battlespace must depend upon having a sensor in position, tasked to detect, and with the ability to detect a target given variables including sensor capabilities, range, weather, time of day, line-of-sight constraints, target observability factors (radar, visual, infrared), and electromagnetic environmental effects such as jamming. Sensors may reside on entities such as aircraft, missiles, munitions, and airbases. NASM detection determinations must fall within 10 percent (preferably within 5 percent) of values calculated by Air Force or OSD-accredited analytical or engineering-level models (such as JMASS), and validated by real-world results where available. Players in the training audience must have access only to information gained by sensors with the capability, tasking, and communications connectivity to report detections. At the most detailed levels, this includes limitations such as an imaging optical sensor on an air-to-surface missile being constrained by terrain, clouds, haze, or light levels. At higher levels, this includes limitations such as development of a cohesive air picture being constrained by connectivity to surveillance platforms such as AWACS and ground-based radars, and the rate at which down-linked data can be transmitted.

(c) Combat Identification and Rules of Engagement (ROE): NASM must include a capability to simulate results of combat identification using aircraft systems to determine the status of detected tracks as friendly, enemy, or unknown. Aircraft models should include realistic use of Identification Friend or Foe (IFF) squawks. Additionally, NASM must include the ability to recognize ROE orders and translate them into behavior rules such as criteria for engagement by aircraft or ground-based weapons systems. A controllable degree of uncertainty in identification is appropriate, depending on the system used for identification (visual, radar, IFF, or other), and uncertainty scaling parameters should be set by the exercise controller. Misidentification should result in the potential for fratricide.

(d) Target Selection: A critical part of battlestaff decision-making is selecting targets for offensive counter-air, strategic attack, and interdiction. Battlestaffs often designate targets by using theater-specific database conventions which may specify defined aimpoints or Desired Mean Points of Impact (DMPI). NASM must relate these with target systems that are represented in the model, allowing battlestaffs to target by DMPI or aimpoint, and see results in the model consistent with real-world expectations. Targets such as ground or naval forces in JSIMS must be observable by air and space entities. Excessive exercise-preparation time might prohibit correlating targets designated by a battlestaff with NASM representations unless some tasks can be automated via support modules. (See §4.a.(5) Support Modules.)

(e) Damage Assessment: NASM must assess the result of air-to-ground attack against any target, however it is represented, and must report this result at two levels. At the lower level, NASM should express results in terms of physical damage consistent with the capabilities of the delivery platform, type of delivery, type of weapon, terrain, weather, and target characteristics. These results should be within 10 percent (preferably within 5 percent) of Joint Munitions Effectiveness Manual (JMEM) data, with a realistic distribution of game results ranging from gross errors (no damage) to higher than expected damage. At the higher level, as stated in Target Selection above, NASM must translate the impact of damage on a specific point into measurable and observable results on a target system. For example:
Cutting a runway surface should translate into a change in maximum launch and recovery rates, dependent upon availability of alternative surfaces and rapid runway repair capability.
A successful attack on maintenance facilities or munitions stockpiles should reduce sortie-generation capability.
An attack on aircraft shelters might result in destruction of sheltered aircraft or degradation in sortie generation.
Attacking a DMPI that corresponds to fuel storage tanks centrally located between two nearby airbases may not result in immediate damage to either airbase, but should (over time) degrade sortie-generation capability if both bases were dependent upon that source of fuel and no alternatives are available.
Battlestaffs will need to know both that a mission was successful ("runway cratered"), and that some impact was reflected in model operations ("airfield closed and estimate 8-12 hours to repair runways"). NASM must represent national infrastructure (transportation, communications, fuel, electricity, logistics, social services, national command authority) for all scenario "sides" in order to credibly represent the effects of strategic attack. These target-system effects should take into account repair capability and

adaptive behavior. The measure of performance for credible damage effects on complex target systems would probably depend on a user "calibration conference" and other analytical models, as part of the verification and validation process. Ultimately, NASM must report target damage in the same detail that would be available using operational systems such as overhead imagery, to include computer-generated images of damaged targets.

(f) Communications: NASM must represent appropriate communications nodes, paths, equipment, and data as items which can be targeted by the training audience (or adversary). Communications networks are part of the battlefield for IW, to include Electronic Combat, Counter Info, C2 Attack, and other Information Operations. C2 links should influence the effectiveness of NASM entities that depend on orders or information. For example, surface-to-air missile (SAM) sites that are cut off from air-defense warning nets and command nets by jamming or direct attack might revert to autonomous modes with potentially decreased effectiveness due to late warning, lack of identification, or suboptimal target selection. The ability to designate C4I targets and observe realistic effects is essential. Performance of modeled communications capabilities, and impacts of lethal and nonlethal attack on communications systems, must be within 10 percent (preferably within 5 percent) of expected values derived from actual operational data or detailed analytical models.

(g) Logistics: NASM must include sufficient logistics detail and enough logistics-related events to train Logistics Readiness Center and AOC personnel. NASM must logistically constrain the mission space, and must generate logistics-training challenges such as execution of Time Phased Force and Deployment Data schedules, deployment force beddown, prepositioned stock management, resupply, re-leveling in-theater resources, redirecting incoming resources, and resetting supply and transportation priorities. NASM must represent resupply and evacuation, including transportation routes and modes (air, waterborne, rail, road, pipeline, and sea). NASM must also represent the functions and capabilities of critical transportation nodes, to include enroute stopover facilities and transshipment points; aerial and sea ports of embarkation and debarkation; road, rail, and air terminals; and fuel-holding and -transfer facilities. NASM must realistically represent logistical impacts of attacks on, or interception or contamination of, these processes, facilities, and their resources. Properly modeling transportation nodes and routes will give more realism in monitoring and managing the flow of resources into and out of the theater. NASM must also represent critical CONUS repair and supply functions for further realism and to provide a basis for analyses of reparable parts flow and sustainment of critical consumables. Combat operations in NASM must generate casualties that can be tracked in NASM and used to drive requirements for patient evacuation.

(h) Airlift: NASM must model airlift-specific capabilities, to include specialized delivery profiles such as airdrop, combat offload, and engine-running offload. NASM must constrain airlift aircraft capacity by factors such as max gross weight, cargo type, max cargo weight, max cargo size, pallet limits, and max passenger seating. NASM must constrain cargo throughput by aircraft and crew availability and use rates, ramp space, material handling equipment, fueling capability, load and offload times, and effects of airfield attacks (runway or taxiway closures; POL availability; decreased runway or taxiway length, width, or load-bearing capacity, etc.). For example, NASM can challenge the training audience by constraining availability and capacity of airlift aircraft, forcing realistic decision-making on resource allocation and scheduling.

(i) Air Refueling: NASM must model air refueling-specific capabilities, to include schedule control (routing, rendezvous times, and track/anchor locations), offload capacity, offload rates, and boom/drogue combinations. For example, NASM can challenge the training audience by constraining availability of tanker aircraft to support deployments and force packaging, forcing resource-allocation decisions in all phases of a scenario.

(j) Space Operations: NASM must model space operations, to include Global Positioning System and communications platforms; missile detection and warning; reconnaissance, surveillance and intelligence collection; environmental monitoring; on-orbit support; space system control; and message and

information distribution. These should be subject to spacelift constraints such as availability of booster and platform, weather, and time to orbit. For example, reconnaissance or surveillance by overhead platforms should depend on the assets being properly positioned, creating a decision-making opportunity for the training audience in managing spacelift and orbit positioning in order to support the collection requirement. NASM must be expandable to integrate new space systems such as the Space Based Infrared System and the Global Broadcast Service as those become operational.

(k) Special Operations: NASM must represent Special Operations activities including direct action on critical targets, insertion or extraction of personnel, strategic reconnaissance, unconventional warfare, combating terrorism, psychological operations, and foreign internal defense. The objective is to allow the training audience to task these missions, observe their execution, and see realistic results reported by the model. For example, insertion of a ground reconnaissance team should result in availability to collect information (sensors) that may not otherwise exist.

(l) Military Operations Other Than War (MOOTW): NASM must be capable of simulating MOOTW, such as arms control, enforcing exclusion zones, enforcing sanctions and maritime intercept operations, counterdrug operations, combating terrorism, military support to civil authorities, nation assistance and support to counterinsurgency, support to insurgency, ensuring freedom of navigation and overflight, protection of shipping, show of force, strikes and raids, recovery operations, noncombatant evacuation, humanitarian assistance, and peace operations. This normally requires representing nonaligned forces, noncombatant groups, and forces unidentified or changing alliances. NASM representations of these operations must focus on the specific functions employed in each such as airlift, air refueling, and surveillance or reconnaissance which can be tasked and directly observed by the training audience.

(m) Human Factors: NASM must include, for each side at the national and unit levels, adjustable levels of human factors which influence object behavior. These would account for variables such as level of training, morale, fatigue, national resolve, political influences, social and religious factors, and chemical or biological attack. These scaling factors should be under the control of the exercise director, but NASM must include a mechanism for directly influencing the scaling factors to represent the cumulative effects of a bombing campaign on the enemy's ability to wage war. Human factors should have measurable and observable impact in the model through behavior such as sortie-generation rates or aircraft and missile launch response times.

Simulated Mistakes and Uncertainty: NASM must be able to accurately portray unplanned or inappropriate outcomes based on human factors such as level of training and variables in combat effectiveness. There are two primary categories: incorrect actions (execution), and inaccurately reported outcomes (uncertainty). Inaccurate reporting will not impact ground truth. The simulation must have the ability to provide the correct information to controllers (to provide an audit trail) for confirmation.

(5) Support Modules: Many important functions associated with the NASM synthetic training environment need not be conducted within the simulation process itself. The success of NASM in providing an effective training opportunity will depend largely on the ability of supporting modules to facilitate scenario and database preparation, to translate real-world orders into model-specific orders at the necessary level of detail, to aggregate results into meaningful information in the formats necessary for use at the battlestaff level, and to translate model data into formats that can be used by external or modeled C4I systems.

(a) Scenario Preparation: NASM must include automated tools to facilitate distributed, collaborative exercise-planning. Exercise planners must be able to use a GUI to tap into existing terrain, environmental, target, and order-of-battle databases; translate the information into model-specific inputs; and then tailor the information to create a scenario that meets training objectives. For example, by using a graphical interface workstation, scenario builders should be able to display SAM sites and C2 nodes, then designate command networks via the GUI.

(b) Aggregation: NASM must provide meaningful information to higher level training audiences when lower level response cells are not present; this entails aggregating results and reporting summary data that would normally be fused by battlestaffs based on tasked collection and reporting. These summary reports should not present full ground truth, but should filter data to provide a product consistent with what a typical battlestaff might provide. Aggregation tasks include reporting on friendly operations as well as on enemy operations (intelligence fusion).

(c) Deaggregation: NASM must be able to translate a highly aggregated player-input order, consisting primarily of the elements of a campaign plan, into the commands necessary to execute at the weapon-system level. Realistically, this is a two-step process. First, NASM must translate a campaign plan or Master Attack Plan (MAP) into the equivalent of an ATO if the training audience does not include battlestaff elements responsible for that product. If targets are not specified in detail, deaggregation at this stage must include automated selection of target subsets which will result in taskings consistent with the intent of the attack plan. Second, NASM must translate the ATO into model-specific mission orders at the level of detail equivalent to a flight plan that incorporates knowledge-based route planning, threat avoidance, range and fuel calculations, and weaponeering if necessary. NASM must perform this two-step orders translation in less than 2 hours.

The input will also include plan execution options, desired courses of action based upon the options taken, and move decision points which when reached will terminate the move and allow the player to adjust his campaign plan. During execution, NASM-provided SAFOR and CGF must be capable of credible battle-management tasks in compliance with high level, aggregated orders such as ROE and general air-defense plans. The level of sophistication for these knowledge-based, force-management "laws" should evolve with available technology and through experience gained with model prototypes. A formalized system to identify "system experts" to train these "expert systems" may be necessary. This may include automated data- and behavior-collection functions integrated into operational weapons systems or mission-training devices.

(d) Displays and Reports Generation: NASM will export situation displays and standardized reports to the controllers and players before, during, and after an exercise. The situation displays must include track data equivalent to those fed by operational systems. The standard reports set must include mission results, target damage, weapons expended, aircraft losses, and kills claimed. In addition, status reports, including logistics and maintenance status, must be available for bases, units, radar sites, SAM and Short Range Air Defense sites, space assets, and C4I infrastructure. NASM must also provide the training audience with the ability to design and modify user-defined reports and to automatically generate these reports based on simulation results, events, or time.

NASM must also translate model-specific data into formats that can be exported directly into operational C4I systems and other simulations. This includes Tactical Digital Information Links (TADIL) for track data, United States Message Traffic Format (USMTF) for standardized Joint message traffic, and North Atlantic Treaty Organization (NATO) 80-50 message format. Reports commonly required include the Tactical Report and Tactical Electronic Intelligence, Initial Photographic Imagery Report, Reconnaissance Exploitation Report, and Joint tactical air reconnaissance/surveillance Mission Report.

(e) After Action Review (AAR): NASM must perform on-site AARs in order to assess and improve the effectiveness of the exercise and to conduct post-exercise analysis. NASM must record user-specified events and data to respond to specific analysis requirements during and after an exercise. The formats include, but are not limited to, three-dimensional, graphical displays on a portable screen, printouts and overhead viewgraphs of data (overlaid on maps when applicable), statistical graphs of resource consumption, and tabular outputs of data as well as text messages. NASM must track special or high-interest information, automatically detect events based upon common errors, perform evaluative and analytic functions, and compare ground truth from the simulation databases with each player's perceived truth and other data. The AAR capability must allow the operator to modify existing output formats or build new displays to support the analysis and review of AAR data.

b. Logistics and Readiness

(1) Availability: NASM availability during a 24-hour-per-day exercise of 1 to 14 days should be at least 90%, with a goal of 95%.

(2) Maintenance: NASM software will comprise portable, reusable modules developed in a modern, supportable programming language using modern programming techniques. The Air Force Agency for Modeling and Simulation (AFAMS) will centrally manage the configuration of deployed software and data components.

(3) Degraded System Performance: NASM operations must degrade gracefully, i.e. NASM must continue operating despite functional limitations or partial failures in the simulation environment, e.g. a communications outage or failure of a computer hardware component. NASM may be required, for example, to execute the scenario more slowly than desired, or remove certain MSOs from the scenario, or reduce the resolution of some or all MSOs, etc. Lack of specialized hardware at any location will not preclude active participation, even if such participation is restricted and requires operator interpretation.

c. Critical System Characteristics

(1) Flexibility: NASM will allow incorporation of advances in hardware and software technologies. NASM must react to changes in the training environment to meet training objectives. Such changes include:
System dependencies (changing system parameters; allowing multiple-level resolution and varying levels of fidelity; adding, deleting, and reconfiguring workstations; and allocating resources and managing exercise components)
Models and simulations (manipulating scenarios, adding or replacing models and simulations, controlling an exercise), and
Operations (changing doctrine)
NASM must be compatible with existing network and interface systems to facilitate implementation. NASM will allow new simulation assets to be integrated into the system on a temporary or permanent basis. NASM must be able to migrate to improved hardware platforms as they become available, or to equivalent theater-owned equipment. NASM must use standard, documented interfaces to promote readily configurable system composition.

(2) Distributed Capability: NASM must provide a distributed mission space that allows exercise participants to receive, process, and transmit commands and information across geographically dispersed locations. In addition, NASM must support training of mobile command posts and units and must accommodate the movement of command posts and units during training exercises. NASM must not require physical collocation of participants in a training exercise. NASM must be capable of operating in either centralized (single site or node) or remote or distributed (multiple site or node) configurations. NASM must allow remote system management and system technical control. NASM must be able to run at a single site for education of the technical controllers prior to an exercise.

(3) Security: All NASM interfaces with operational C4I systems must contain sufficient operational and systematic safeguards to prevent inadvertent insertion of simulation information into the on-line, real-world information. NASM must meet all security requirements for interoperability with theater and national C2 systems, and must be able to interchange data with these systems. NASM shall not prohibit operation in an EMSEC-controlled environment. NASM will require protection from Information Security threats as defined by the designated approval authority at each anticipated deployment site. Necessary security measures, however, are external to NASM and shall be provided by the respective simulation centers and users, as appropriate. The NASM architecture must also be capable of incorporating multilevel and compartmented security solutions, when available. NASM capability must be releasable to coalition partners given proper approval. NASM data may be releasable on a case-by-case basis.

(4) C4I Interfaces: NASM must interoperate with designated C4I systems, and with future systems as required to meet training objectives. All NASM interfaces with Air Force and joint C4I systems will meet, respectively, the Air Force and joint requirements for interoperability certification. Trainees must be able to use the same C4I systems that they would normally use, gather information via wartime channels, and issue the same commands and tasking as in wartime. At the same time, NASM must not adversely impact any operational C4I systems. NASM must ensure unambiguous interchange of data between itself and external C4I systems. Interfaces must evolve as systems such as TBMCS evolve from USMTF to access to common databases. Anticipated interface requirements are listed below. Other interfaces may also be required.

Air Force Mission Support System
Combat Integration Capability
Command and Control Information Processing System (C2IPS)
Defense Message System
Deliberate and Crisis Action Planning and Execution System
Global Command and Control System
Global Combat Support System
Global Decision Support System
Joint Deployable Intelligence Support System
Joint Engineering Estimation Planning System
Tactical C4I
TADIL, (e.g. A,B,J)
Tactical Elint Processor
Tactical Information Broadcast Service
Tactical Receive Equipment
Tactical Related Applications
TBMCS

5. Program Support

a. Maintenance Planning

Maintenance planning includes all activities for the life cycle support in accordance with (IAW) Air Force Instruction (AFI) 10-602, Determining Logistics Support and Readiness Requirements. All NASM maintenance will use existing technical orders, procedures, and best commercial practices. These require that maintenance be planned and accomplished to ensure optimum effectiveness with minimum maintenance costs. There will be two levels of maintenance: organizational and depot.

(1) Organizational-level Maintenance: Maintenance at this level includes fault isolation and troubleshooting, repair of prime mission equipment (generally limited to replacement of faulty Line Replaceable Units), preventive or scheduled maintenance and testing, and software diagnostics. The contractor's repair level analysis differentiates between software and hardware failures, and determines the appropriate action and repair location.

(2) Depot-level Maintenance: Off-equipment maintenance can be accomplished at the site repair facility, Software Support Facility (SSF), CONUS depot, or a contractor or vendor facility. Off-equipment maintenance performed at the depot includes technical assistance and active maintenance beyond the responsibility and capability of organizational maintainers; bench check, repair, or overhaul of unserviceable components; service engineering of modifications; repair and calibration of specialized test equipment; modifications that require additional man hours, facilities, or equipment not available at the organizational level; software diagnostic systems; and emergency on-site support.

b. Support Equipment

NASM must minimize support equipment for maintenance, require only standard test equipment, and include fault-isolation capabilities to diagnose failures at a level commensurate with the final support concept. The Logistics Support Analysis must identify support-equipment requirements, and an assigned National Stock Number must identify all support equipment that has been approved for use with NASM. Support equipment must be on site prior to fielding NASM.

c. Human Systems Integration

(1) Human Computer Interface (HCI): NASM must include tutorials, on-line references, manuals, and context-sensitive "help screens," to include all system configuration operations and operator maintenance. The HCI must be IAW the Joint Technical Architecture (JTA) and the Defense Information Infrastructure Common Operating Environment.

(2) Manpower Support: At a minimum, NASM must be capable of being operated and maintained within current manpower authorizations and skills. The goal is to reduce training-support personnel for CINC/CJTF exercises by two-thirds.

(3) Training and Training Support: For each phase of the program, the developer must provide Type I, Train the Trainer (contractor) operations and maintenance training for the initial cadre of instructors and acceptance testing participants, as well as Type I software maintenance and training for software support personnel. This training must include tutorials, manuals, and "help screens" for all system-configuration operations and operator maintenance. Host sites will identify any unsatisfied Type I follow-on training requirements. Training for the system controllers must cover the interaction with NASM and role-playing techniques. It is assumed that students have the basic operational knowledge of the position that they are to portray in an exercise.

d. Computer Resources

(1) Open System Architecture and Standards: NASM must conform to the HLA developed by the DoD-wide Architecture Management Group.

(2) Software: NASM must use COTS software, and should consider nondevelopmental DoD software, to the maximum extent possible within the constraints of the life-cycle maintenance to reduce manpower and other support resources and permit ready technological upgrades. NASM software must include quality, nonproprietary documentation and source code that facilitates software maintenance.

NASM software must be modular so that it can be changed without affecting the design or implementation of other modules. It must employ error-management aids and permit users to obtain on-line guidance by requesting help screens. Following the output of an error message, users should be able to request additional information at levels of increasing detail.

NASM must not hard-code any data (i.e., parameters of the models, rules for expert systems, addresses for network nodes) into the software. NASM must provide the flexibility to change system parameters, rules, and network configuration during execution without disrupting an exercise.

e. Other Logistics Considerations

(1) Storage Areas: Permanent, environmentally controlled facilities for fixed-site equipment must include storage areas for NASM components. Any transportable configuration of NASM must be able to operate out of temporary facilities that may or may not be environmentally controlled. Selected facilities must be capable of supporting exercises in a secure mode.

(2) Supply Support: Delivery of initial spares must be concurrent with, or prior to, equipment installation. Each host site will provide all follow-on spares and supply support.

(3) Technical Data: Technical orders, user's manuals, analyst's manuals (to include detailed descriptions of model algorithms), and vendor documentation for each level of operation and repair must include illustrated parts breakdowns, parts listings, cabling diagrams and cable pin-outs, theory of operation, and maintenance and troubleshooting guides. The NASM developer must formally verify and validate technical orders and vendor documentation. A plan for verifying and validating these materials must explain the step-by-step procedures to be accomplished at scheduled reviews in coordination with NASM users. The system must provide in the required format any system-unique documentation required to operate, troubleshoot, and maintain the system.

(4) Engineering and Data Rights: Engineering data and data-rights requirements include acquisition of commercial data and unrestricted data rights on software developed for NASM. At delivery, NASM must include site licenses for COTS software until Full Operational Capability (FOC). After FOC, each host site will maintain its required site licenses.

(5) Facilities and Land: NASM must allow installation within existing facilities and sites. ESC, in coordination with HQ USAF/XOC, AFAMS, and other appropriate agencies, will determine requirements for the SSF.

f. Command, Control, Communications, Computers, and Intelligence

As stated in §4.c.(4), C4I Interfaces, NASM must interoperate with designated C4I systems, and with future systems as required to meet training objectives. All NASM interfaces with Air Force and joint C4I systems will meet, respectively, the Air Force and joint requirements for interoperability certification. Trainees must be able to use the same C4I systems that they would normally use, gather information via wartime channels, and issue the same commands and tasking as in wartime. At the same time, NASM must not adversely impact any operational C4I systems. NASM must ensure unambiguous interchange of data between itself and external C4I systems. Interfaces must evolve as systems such as the Theater Battle Management Core System (TBMCS) evolve from USMTF to database updates with alerting. Anticipated interface requirements are listed below. Other interfaces may also be required.

Air Force Mission Support System
Combat Integration Capability
Command and Control Information Processing System (C2IPS)
Defense Message System
Deliberate and Crisis Action Planning and Execution System
Global Command and Control System
Global Combat Support System
Global Decision Support System
Joint Deployable Intelligence Support System
Joint Engineering Estimation Planning System
Tactical C4I
TADIL, (e.g. A,B,J)
Tactical Elint Processor
Tactical Information Broadcast Service
Tactical Receive Equipment
Tactical Related Applications
TBMCS

g. Transportation and Basing

NASM hardware (such as workstations) must be capable of operating in a centralized or a distributed mode. Planned, primary host sites include simulation centers, training sites, educational facilities, and command centers. NASM equipment shall be transportable via military and commercial air, land, and sea transportation.

h. Standardization, Interoperability, and Commonality

All NASM components must comply with DoD and Air Force requirements for standardization and interoperability. NASM will use best commercial practices to the maximum extent possible and will consider standardization and interoperability, where possible, with NATO and other allies. NASM must use standard external interfaces to the extent possible. All interfaces must be IAW the DoD JTA, Air Force Technical Reference Codes, and other approved C4I interoperability guidance and standards.

i. Mapping, Charting, and Geodesy (MC&G) Support

MC&G requirements for NASM must be consistent with the JSIMS development approach. NASM will use standard digital products, software, and services of the National Imagery and Mapping Agency (NIMA). At Initial Operational Capability (IOC), NASM must meet the resolution of Digital Terrain Elevation Data (DTED) and Digital Feature Analysis Data Level 1, and Interim Terrain Data (ITD) and Vector Product Format (VPF) ITD. The FOC goal is to meet DTED Level 5, and VPF products Vmap0-2, UVMap, and ITD. NASM must use the World Geodetic System 1984 Datum.

j. Environmental Support

NASM requires environmental support in terms of accurate environmental (meteorological, oceanographic, space, terrain) data for use during exercise scenarios. Refer to §4.a.(2) for details. Unique support requirements will be drawn from CINCs' integrated priorities lists.

6. Force Structure

The initial fielding locations for NASM are:

a. USAF Battlestaff Training School, Hurlburt AFB, FL
b. WPC, Einsiedlerhof AS, Germany
c. Korean Air Simulation Center, Osan AB, Korea
SSF, NASM Contractor Facility

7. Schedule Considerations

At JSIMS IOC, NASM will provide the Air Force's air and space representations to satisfy JSIMS IOC requirements. At IOC, JSIMS will focus on support for training Unified Combatant Command staffs, JTF Commander and staff, and Component Commander and staff at the strategic-theater and operational levels of war. At FOC, JSIMS will provide training for the strategic-national to tactical levels of war, including the three Air Force Functional Capabilities found in the JSIMS System Segment Specification, and NASM representations' fidelity and resolution will satisfy these requirements.

ATTACHMENT 1
Requirements Correlation Matrix
PART I

As of 15 Apr 98

SYSTEM CAPABILITIES
AND CHARACTERISTICS
* = Key Performance Parameter
THRESHOLDS
OBJECTIVES 1. JSIMS KPP capabilities. Para 4* Provide JSIMS with air and space capabilities required to meet JSIMS KPPs per JSIMS ORD. 2. Core structure and configuration. Para 4a(1)(a) * Compliant with JSIMS architecture. 3. Model interfaces. Para 4a(1)(b) Interoperate with live, virtual, and constructive simulations outside JSIMS. 4. Data deconfliction. Para 4a(1)(c) Consistent data at all sites regardless of where outcome is initially resolved. 5. Force sides. Para 4a(1)(d) Friendly, neutral, unknown, and opposing sides represented and changeable during play. 6. Transparency. Para 4a(1)(e) Primary training audience able to operate from home station or deployed facilities without model-specific equipment or communications. 7. Resolution. Para 4a(1)(f) Levels of detail and fidelity selectable to suit training audience. 8. Warfighter In The Loop (WITL) capability. Para 4a(1)(g) Able to insert WITL at any level of simulation. 9. Selectable time compression. Para 4a(1)(h) 1:1 to 4:1 (with limited WITL and limited C4I connectivity) 1:10 slower than real time; 100:1 faster than real time (with fully automated CGF) 10. NASM-specific graphic user interfaces available. Para 4a(1)(i) Train players to familiarity level within 2 hours, proficiency in 6 hours; controllers in 12 hours. 11. Technical controller requirements. Para 4a(1)(j) Start, freeze, stop, or restart model; save all or selected data; vary game speed; override events; manage system configuration. 12. Controller privileges. Para 4a(1)(k) Exercise controllers provided with full ground truth, response cell controller permissions limited to "own" forces and perceived truth. 13. Player privileges. Para 4a(1)(l) Control and information limited to "own" forces and perceived truth. 14. Coordinate systems. Para 4a(2)(a) Track objects worldwide by lat/long and altitude; accept UTM. 15. Terrain. Para 4a(2)(b) NIMA data represented at selectable levels of resolution, and factored into detection and engagement models. Overhead map views available. Detailed terrain views available for display from any angle, elevation, range, or cockpit perspective, and at increased levels of detail when available. 16. Weather and Atmospheric Conditions. Para 4a(2)(c) Represent weather and atmospheric conditions and their effects on operations. 17. Model entities defined with characteristics and capabilities, tracked and reported throughout exercise. Para 4a(3) Represent airbases, aircraft, spacecraft, space launch systems, missiles, launch sites, munitions, sensors, comm sites, information, etc. Capable of incorporating new or potential systems. 18. Movement and navigation, constrained by weather, terrain, routing, payload, performance. Para 4a(4)(a) Speed, range, and payload within 10% of detailed operational performance planning guides. Speed, range, and payload within 5% of detailed operational performance planning guides. 19. Detections, constrained by weather, terrain, sensor capabilities, target. Para 4a(4)(b) Within 10% of actual performance data or detailed analytical models. Within 5% of actual performance data or detailed analytical models. 20. Combat identification. Para 4a(4)(c) Engagements comply with ROE; misidentification and fratricide possible and controllable. 21. Targeting of NASM entities and shared objects from other models. Para 4a(4)(d) Target by model name, or by DMPI or target #. 22. Damage assessment. Para 4a(4)(e) First-order effects within 10% of JMEM data; data dependent upon ability and tasking to collect and report; long-range and infrastructure effects represented and observable by training audience. First-order effects within 5% of JMEM data; infrastructure effects validated; simulated BDA imagery available. 23. Communications systems, nodes, and links. Para 4a(4)(f) Targetable by IW, including direct attack, jamming; effects within 10% of analytical models. Effects within 5% of analytical models. 24. Logistics. Para 4a(4)(g) All operations logistically constrained, logistics functions represented. 25. Airlift and air refueling operations.
Para 4a(4)(h) and 4a(4)(i) Represent cargo, pax, and refueling operations and constraints. 26. Space operations. Para 4a(4)(j) Represent launch ops, satellite ops, reconnaissance, surveillance, tactical detection and warning, navigation, communication, environment monitoring, prompt strike, space

surveillance, counter space, and missile defense. 27. Special Operations activities. Para 4a(4)(k) Represent direct action, special reconnaissance, unconventional warfare, foreign internal defense, psyops, and counter-terrorism. 28. MOOTW. Para 4a(4)(l) Capable of simulating MOOTW conditions. 29. Human factors. Para 4a(4)(m) Performance scaling factors incorporated at all levels; both controller- and model-driven. 30. Simulated mistakes and uncertainty. Para 4a(4)(n) Controllable levels of execution and reporting errors. 31. Scenario preparation. Para 4a(5)(a) Automated database and GUI tools available to facilitate distributed, collaborative exercise-planning. 32. Aggregation and deaggregation. (Knowledge-based tools to add detail to higher-level orders and perform data fusion and reporting.) Para 4a(5)(b) and 4a(5)(c) Translate MAP into ATO and then to entity-level orders within 2 hours; automate basic battle-management tasks. Expand knowledge-based planning tools, to include "intelligent" CGF capable of planning and directing forces in "hands off" mode. 33. Display and reports generation. Para 4a(5)(d) Generate standardized reports; create and modify user-defined reports. 34. AAR. Para 4a(5)(e) Provide standardized and user-defined AAR aids including summaries, charts, and motion replays. 35. Availability. Para 4b(1) During 24-hour ops for up to 14 days, availability of at least 90%. During 24-hr ops for up to 14 days, availability of 95%. 36. Security. Para 4c(3) Meet security requirements for interoperability with theater and national systems. Incorporate multilevel security solutions, when available. 37. C4I Interfaces. Para 4c(4) Interoperate with operational C4I systems. [See list in para 4c(4)] Include future systems TBD. 38. Manpower. Para 5c(2) No increase in manpower authorizations or skills. Reduce training support personnel for CINC/CJTF exercises by two-thirds.

REQUIREMENTS CORRELATION MATRIX
PART II
(Supporting Rationale for System Characteristics and Capabilities)

As of 15 Apr 98

General Comments. AWSIM is the air-power simulation currently used to support Air Force, joint and combined training exercises and other training programs. AWSIM has significant shortcomings in its ability to realistically portray the full range of aerospace functions and capabilities. AWSIM also has many functional, maintenance and enhancement limitations associated with its hardware and software and ability to interoperate with the simulation systems of the other Services. Operations and support staffs have identified these shortcomings for many years. In light of the many significant advances that have occurred in software technologies and hardware, it is no longer practical or efficient to attempt the significant enhancements that are now required. In addition, the numbers of control-staff personnel required to operate and maintain AWSIM when supporting distributed exercises is excessive. NASM will overcome these deficiencies by integrating the full range of air and space functions within a common framework, using modern simulation technologies. NASM will interoperate with operational C4I systems and other constructive, virtual and live simulations.

References:

(1) USAF Modeling and Simulation Master Plan, HQ USAF/XOM, 1 Dec 95.

(2) DoD Modeling and Simulation Master Plan (DoD 5000.59-P), Oct 95.

(3) Joint Simulation System (JSIMS) Master Plan, JSIMS Joint Program Office, 7 Nov 94.

(4) Joint Simulation System (JSIMS) Operational Requirements Document, Joint Warfighting Center, 17 Nov 97.

(5) National Air and Space Warfare Model (NASM), Mission Need Statement, HQ USAF 009-93, 8 Aug 94.

Parameter 1 – Overall System Capabilities. NASM is a partner program in the JSIMS Enterprise. As such, NASM must operate within JSIMS and provide the air and space capabilities required to meet JSIMS KPPs.

Parameter 2 -- Core Structure. NASM is one of the JSIMS partner programs and will provide air and space objects to JSIMS. As such, NASM must operate within the JSIMS architecture.

Parameter 3 -- Model Interfaces. The ability to interoperate with live, virtual, and other constructive models is central to the Air Force Modeling and Simulation vision of a seamless synthetic training environment to support warfighters, from the unit level to theater CINCs.

Parameter 4 -- Data Deconfliction. NASM must consistently communicate the outcomes of events to all distributed locations, without interrupting or delaying time-synchronized interfaces, to ensure training realism and accomplish training objectives.

Parameter 5 -- Force Sides. The nature of modern conflict is oriented towards joint and combined (coalition) warfare and MOOTW, where the affiliation of participants can differ in subtle or drastic ways and can change quickly. Engagement ROE is also highly dependent on classification as friendly, hostile,

unknown, or neutral. NASM must provide to the training audience the challenges posed by modern warfare and MOOTW.

Parameter 6 -- Transparency. A primary requirement for NASM is the ability to train battlestaffs at their home station or deployed locations using their normal C4I equipment, procedures and processes, instead of forcing them to learn model-specific equipment or relying on exercise-specific communications. In this sense NASM must be "transparent" to the primary training audience.

Parameter 7 -- Resolution. The level of detail in the model and in the reported data should be selectable based on available data and exercise training objectives. For example, if wing-level logistics training is an exercise objective, then the model would need to generate inventory and consumption rates for fuel, weapons, spare parts, engines, and personnel (by skill codes). If this level of detail is not available for database inputs, or if lower-level logistics play is not required, there is no need to ask the model to calculate or report this data.

Parameter 8 -- Warfighter In The Loop (WITL). NASM must support training audiences that range from unit level to theater CINCs. If lower-echelon participants are involved, then NASM must be able to insert their decision-making into model activities; NASM must also be able to "drill down" to high-fidelity models (such as virtual combat simulators) to resolve outcomes and portray the results.

Parameter 9 -- Time Compression. Training requirements dictate the need to slow the simulation down for close scrutiny of complex operations or to speed the simulation up in order to cover campaign-length scenarios in a matter of days or hours. This requires the ability to specify run rates as a technical control function, as well as the capacity to process vast amounts of data during large scenarios with many participants and a high level of activity. A compression factor of 4:1 is appropriate to allow the model to "catch up" to real time after delays or failures, or to allow playing 48 hours of simulated operations in a 12-hour duty day. A ratio of 100:1 would be useful to generate overviews of mission packaging or rehearsal drills.

Parameter 10 -- Graphic User Interfaces. Current player and controller interfaces include many model-specific tasks that are labor intensive and difficult to learn. NASM "organic" interfaces need to be simple, efficient, intuitive, and easy to learn in order to keep manpower costs and training time to a minimum. User acceptance ultimately depends on developing a friendly interface. A player train-up time of two hours to the familiarity level is appropriate for seminar settings, and six hours is essentially a duty day plus administrative overhead for full-scale exercises. Twelve hours is essentially two duty days with overhead for training exercise controllers. Based on the expert opinion of simulation-center staff experienced in all phases of training exercises, the numbers cited are approximately what is currently required to develop familiarity and proficiency with their current suite of models.

Parameter 11 -- Technical Controller Requirements. Based on the expert opinion of simulation-center staff experienced in all phases of training exercises, NASM technical controllers require these capabilities to ensure effective training.

Parameter 12 -- Controller Privileges. Exercise controllers and response-cell controllers act as buffers between the training audience and the model. These controllers require varying levels of authority for tasks such as overriding model outcomes and "editing" player inputs to ensure realistic play in the exercise.

Parameter 13 -- Player Privileges. NASM must restrict exercise participants and control cells to control of their own forces. NASM must limit players' access to information to what they would realistically be able to obtain given the capabilities of reconnaissance, surveillance, and intelligence systems, collection tasking, and communications connectivity.

Parameter 14 -- Coordinate Systems. NASM must not restrict air and space missions by geographical limits such as a "designated playbox". NASM objects must be able to move anywhere worldwide, using

latitude/longitude/altitude as the primary coordinate system. NASM must accommodate other coordinate systems via automatic translation, such as when ground targets are passed using UTM coordinates.

Parameter 15 -- Terrain. Current air models use a "flat but curved earth", ignoring critical factors such as line-of-sight restrictions to detections, navigation, target acquisition, and engagement outcomes. Training realism requires the use of NIMA databases and modern modeling techniques.

Parameter 16 – Weather and Atmospheric Conditions. Current models do not adequately represent the natural air-and-space environment, including specifically atmospheric conditions, nor the environment's effects on the ability to conduct operations or the outcome of attempted detections, communications, navigation, target acquisition, or combat engagements. Proper representation of the environment and its effects is essential to training realism.

Parameter 17 -- Model Entities. The most visible parts of any air model are the "playing pieces" that can be tracked, displayed, and reported on throughout an exercise. Accurate representation of the capabilities and characteristics of each entity is essential for training realism and accomplishment of training objectives.

Parameter 18 -- Movement and Navigation. Current models do not constrain entities' movements. For example SAM sites may travel by surface in straight lines over water and through mountains, aircraft range does not depend on configuration (payload, drag, external fuel), and all navigation is 100% accurate. NASM must realistically constrain movement and navigation, and bring speed, range, and payload capabilities of aircraft and missiles closer to real-world figures in order to be credible. Based on the expert opinion of simulation-center staff experienced in all phases of training exercises, accuracy within 10 percent is approximately the level of acceptable credibility for operational-level exercises, and accuracy to within 5 percent will generally stand up to close scrutiny and is more defensible.

Parameter 19 -- Detections. Target detection and acquisition are critical steps in surveillance and engagements of all types, yet detection calculations in current models do not depend on terrain or weather, and representation of sensor capabilities and target observability factors is poor. Based on the expert opinion of simulation-center staff experienced in all phases of training exercises, NASM must accurately represent these to provide credible training.

Parameter 20 -- Combat Identification. Current detection and engagement models do not represent the identification process or ROE, do not account for identification capabilities or constraints, and do not allow fratricide. ROE balance the risk of friendly losses against the need to engage the enemy efficiently and at maximum range. Fratricide is an important consideration for battlestaffs in developing or refining theater ROE. Reducing or eliminating fratricide and ensuring positive hostile identification require strict compliance with ROE. NASM must represent ROE, identification processes, and fratricide to provide effective training.

Parameter 21 -- Targeting. Operational battlestaffs conduct campaign planning in terms of strategy, objectives, and phasing. Battlestaffs identify and prioritize target systems and associated targets by the order in which they are attacked, the desired results, and the weight of effort required to achieve desired results. They assign air-to-surface mission tasks in terms of individual targets or responsibility for areas of coverage. In current models, there is rarely a one-to-one relation between model entities (target systems) and individually tasked or assigned targets. NASM must accommodate targeting by operational conventions, and translate those orders into observable actions in order to provide useful training for battlestaffs. NASM must also be able to represent as targets those entities which are shared with or provided by other models.

Parameter 22 -- Damage Assessment. An important function of any training simulation is to provide feedback to the training audience on the results of operations they direct. Specific mission results should be available and consistent with JMEM data considering the weapon and delivery used, target

characteristics, terrain and threat environment, and weather. A credible, random distribution of results must allow outcomes from gross error or misfire to "lucky hit". Based on the expert opinion of simulation-center staff experienced in all phases of training exercises, damage-assessment accuracy within 10 percent is the level of acceptable credibility for operational-level exercises, and accuracy to within 5 percent will generally stand up to close scrutiny and is more defensible. Although information such as "mission successful, bombs on target, hangar damaged" is useful and desired, what the training audience needs, and what NASM must deliver, is a realistic and observable change in modeled status, capability, or behavior. For example, the mission objective is rarely just to put a bomb on target, but rather to change the ability of an airfield to generate sorties or launch or recover aircraft. NASM must show the effects of damage to complex target systems such as airfields, transportation networks, and command and control networks. Availability of these data to the players depends on having appropriate means of collection and reporting available and tasked.

Parameter 23 -- Communications. Current models do not represent communications as a viable IW target area. Based on the expert opinion of simulation-center staff experienced in all phases of training exercises, NASM must show realistic, credible effects of direct attack on communications nodes, jamming of communications links, and other information operations to provide effective training.

Parameter 24 -- Logistics. Current models are not subject to realistic logistic constraints, and do not adequately generate logistics challenges and decision-making opportunities for the training audience. NASM must provide sufficient logistics detail to represent activities such as deployment and beddown, resupply, repair, and inventory management to satisfy battlestaff training requirements.

Parameter 25 -- Airlift and Air Refueling. NASM must represent airlift and tanker operations with the ability to show realistically constrained movement of cargo and passengers, air refueling operations, and competition for resources both in transit to and in the theater of operations.

Parameter 26 -- Space Operations. Simulation of space support to theater operations is essential to battlestaff training and must be properly represented in NASM.

Parameter 27 -- Special Operations. Simulating the full range of special operations as a threshold capability is essential to train battlestaff personnel in the unique capabilities of special operations forces and to ensure that the impact of special operations is realistically portrayed in the exercise.

Parameter 28 -- Military Operations Other Than War (MOOTW). MOOTW is a relatively new but high-interest challenge for battlestaff training. Although MOOTW and war may often seem similar in action, MOOTW focus on deterring war and promoting peace while war encompasses large-scale, sustained combat operations to achieve national objectives or to promote national interests. MOOTW are more sensitive to political considerations and often the military may not be the primary player. MOOTW follow more restrictive ROE and a hierarchy of national objectives. NASM must provide the capability to train battlestaffs in the conduct of MOOTW.

Parameter 29 -- Human Factors. NASM must represent human factors such as morale, training, fatigue, and national resolve as a part of all behavioral models to increase training realism. These factors must be controllable at both the unit level and for each "side" by exercise directors.

Parameter 30 -- Mistakes and Uncertainty. Simulating mistakes in execution and reporting is essential to improving training realism.

Parameter 31 -- Scenario Preparation. The volume of information and level of detail required to prepare scenarios for large-scale exercises require automated tools in order to keep time and manpower requirements down to an affordable level.

Parameter 32 -- Aggregation and Deaggregation. NASM must break down player inputs, such as the ATO, and add detail in order to generate model-specific mission orders. The tasks of creating detail where none exists, and of summarizing results into coherent assessment reports, require automated, knowledge-based processing tools. Based on the expert opinion of simulation-center staff experienced in all phases of training exercises, these tools and associated time limitations are necessary to run exercises in real time while keeping response-cell manning requirements to an affordable level, or to run any scenario faster than real time. Translating an ATO into model-specific mission orders is a current capability.

Parameter 33 – Display and Reports Generation. NASM must include support modules that can translate model results into standardized formats that are compatible with and can be delivered to operational systems.

Parameter 34 – After Action Review. Effective training requires that the training audience be provided immediate and understandable assessments of what happened and why it happened. To provide these timely assessments within required exercise support staff limitations, NASM must include support modules to automate exercise analysis and review.

Parameter 35 -- Availability. NASM must be capable of 24-hour operations with all interfaces intact, and the ability to recover quickly from any overall system failure with minimal loss of data. Large-scale exercises are enormously expensive, and the training audiences cannot afford extended down time which reduces scenario progress and therefore training opportunities. Extended down time also degrades overall credibility of the simulation, especially when the "game clock" cannot be made to match real-world time.

Parameter 36 -- Security. NASM must insert required operational and systematic security safeguards at all interfaces. NASM must restrict scenario and database access, even when non-US forces are part of the training audience and theater, coalition, and national systems are used. Multilevel security will facilitate meeting coalition and other training requirements.

Parameter 37 – C4I Interfaces. A primary objective of the NASM and JSIMS training environment is to allow the training audiences to work from their normal operational locations, using operational C4I systems as their primary interface to simulations.

Parameter 38 -- Manpower. One of the most significant shortfalls of the current system is the high full-time manpower overhead need for technical control, exercise scenario preparation, and software maintenance. An important requirement for NASM is the ability to provide a better training environment without increasing manpower or skills requirements over current exercise requirements. The goal is to reduce manpower needs by two-thirds.

REQUIREMENTS CORRELATION MATRIX
PART III
(Rationale & Needs/Requirements Changes)

As of 15 Apr 98

General Comments: The following parameters have changed since the NASM ORD dated 21 May 96.

Parameter 1 – Aligns NASM KPPs with JSIMS KPPs.

Parameter 2 – Core Structure and Configuration. References to NASM running in a stand-alone mode were deleted. The system is integrally tied to the JSIMS core infrastructure.

Parameter 5 – Force Sides. Dropped as a KPP to align with JSIMS KPPs.

Original Parameter 9 – Selectable Time Step. Deleted. Original requirement imposed a design constraint on JSIMS architecture.

Parameter 9 -- Time Compression. Time compression factors were changed to be consistent with the JSIMS ORD.

Parameter 15 -- Terrain. References to Defense Mapping Agency were changed to National Imagery and Mapping Agency (NIMA).

Parameter 17 – Model Entities. Dropped as a KPP to align with JSIMS KPPs. Reference to other JSIMS models was deleted as the system will not be a confederation of different models.

Parameter 22 – Damage Assessment. Dropped as a KPP to align with JSIMS KPPs.

Parameter 35 -- Availability. This parameter was changed from a 30-day to a 14-day operations requirement; and from down time less than one hour every four days, to an availability of 90% (objective 95%). This was changed to be consistent with the JSIMS ORD.

Parameter 36 -- Security. References to TEMPEST were changed to Emissions Security (EMSEC).

ATTACHMENT 2
GLOSSARY

Aggregate - To create an aggregated entity from individual entities.

Aggregation - The ability to group entities while preserving the effects of entity behavior and interaction while grouped.

Constructive Simulations - Consist of traditional wargames, models, and analytical tools. The simulations usually run on computers with humans interacting external to the simulation. The performance of entities in the simulation derives from random outcomes based on input probability distributions rather than from human interaction. The level of detail in constructive simulations can vary greatly from a highly aggregated one, where the basic entities in the model are, for example, divisions or battalions, to one that describes the behavior of an individual weapon system by representing its individual components.

Live Simulation - Real equipment in the field operating in a simulation.

Mission Space - The environment, entities, and behavior (actions and interactions) inherent in any represented missions or mission areas.

Model - (1) A representation (executable or not) of real things or events, (e.g. terrain, air, space, land, sea). (2) A physical, mathematical, or otherwise logical representation of a system, entity, phenomenon, or process.

Scenario - (1) Description of an exercise (initial condition in military terms). It is part of the session database which configures the units and platforms and places them in specific locations with specific missions. (2) An initial set of conditions and time lines for significant events imposed on trainees or systems to achieve exercise objectives.

Simulation - (1) A model that behaves or operates like a given system when provided a set of controlled inputs. (2) The process of developing or using a model as in (1). (3) An element of a special kind of model that represents at least some key, internal elements of a system and describes how those elements interact over time.

Simulation Entity - An element of the synthetic environment that is created and controlled by a simulation application. It is possible that a simulation application may be controlling more than one simulation entity.

Simulator - (1) A special case of virtual simulation that provides an encapsulated virtual environment. (2) A device, computer program, or system that performs simulations. (3) For training, a device which duplicates the essential features of a task and provides for direct practice. (4) A physical model or simulation of a weapon system, set of weapon systems, or a piece of equipment which represents some major aspects of the equipment's operation. (5) A training device that permits development and practice of the necessary skills for accomplishing flight operational tasks, to a prescribed standard of airman competency, in a specific aircraft and duty position.

Virtual Simulation - A simulation involving real people operating simulated systems. Virtual simulations inject human-in-the-loop in a central role by exercising motor control skills, decision skills, or communication skills. Form of a simulation in which entities exist in effect or in essence, although not in actual form.

ATTACHMENT 3
ACRONYMS

AAR	After Action Review
AFAMS	Air Force Agency for Modeling and Simulation
AFDD	Air Force Doctrine Document
AFI	Air Force Instruction
AMC	Air Mobility Command
AOC	Air Operations Center
ATO	Air Tasking Order
AWACS	Airborne Warning and Control System
AWSIM	Air Warfare Simulation
C2	Command and Control
C2IPS	Command and Control Information Processing System
C4I	Command, Control, Communications, Computers, and Intelligence
CGF	Computer Generated Forces
CINC	Commander in Chief
CJTF	Commander, Joint Task Force
CONUS	Continental United States
COTS	Commercial Off The Shelf
DMPI	Desired Mean Point of Impact
DoD	Department of Defense
DTED	Digital Terrain Elevation Data
ELINT	Electronic Intelligence
EMSEC	Emissions Security
ESC	Electronic Systems Center
FOC	Full Operational Capability
GUI	Graphic User Interface
HCI	Human Computer Interface
HLA	High Level Architecture
HQ	Headquarters
IAW	In Accordance With
IFF	Identification Friend or Foe
IOC	Initial Operational Capability
ITD	Interim Terrain Data
IW	Information Warfare
JMASS	Joint Modeling and Simulation System
JMEM	Joint Munitions Effectiveness Manual
JSIMS	Joint Simulation System
JTA	Joint Technical Architecture
JTF	Joint Task Force
KPP	Key Performance Parameter
MAP	Master Attack Plan

MC&G Mapping, Charting and Geodesy
MNS Mission Need Statement
MOOTW Military Operations Other Than War

NASM National Air and Space (Warfare) Model
NATO North Atlantic Treaty Organization
NDI Non-Developmental Item
NIMA National Imagery and Mapping Agency

ORD Operational Requirements Document
OSD Office of the Secretary of Defense

PA&E Program Analysis and Evaluation
POL Petroleum, Oils, and Lubricants

ROE Rules of Engagement

SAFOR SemiAutomated Forces
SAM Surface-to-Air Missile
SSF Software Support Facility

TADIL Tactical Digital Information Link
TBD To Be Determined
TBMCS Theater Battle Management Core System
TED Threat Environment Description

USAF United States Air Force
USMTF United States Message Traffic Format
UTM Universal Transverse Mercator

WITL Warfighter In The Loop
WPC Warrior Preparation Center

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